United States
Department of
Agriculture

Forest Service

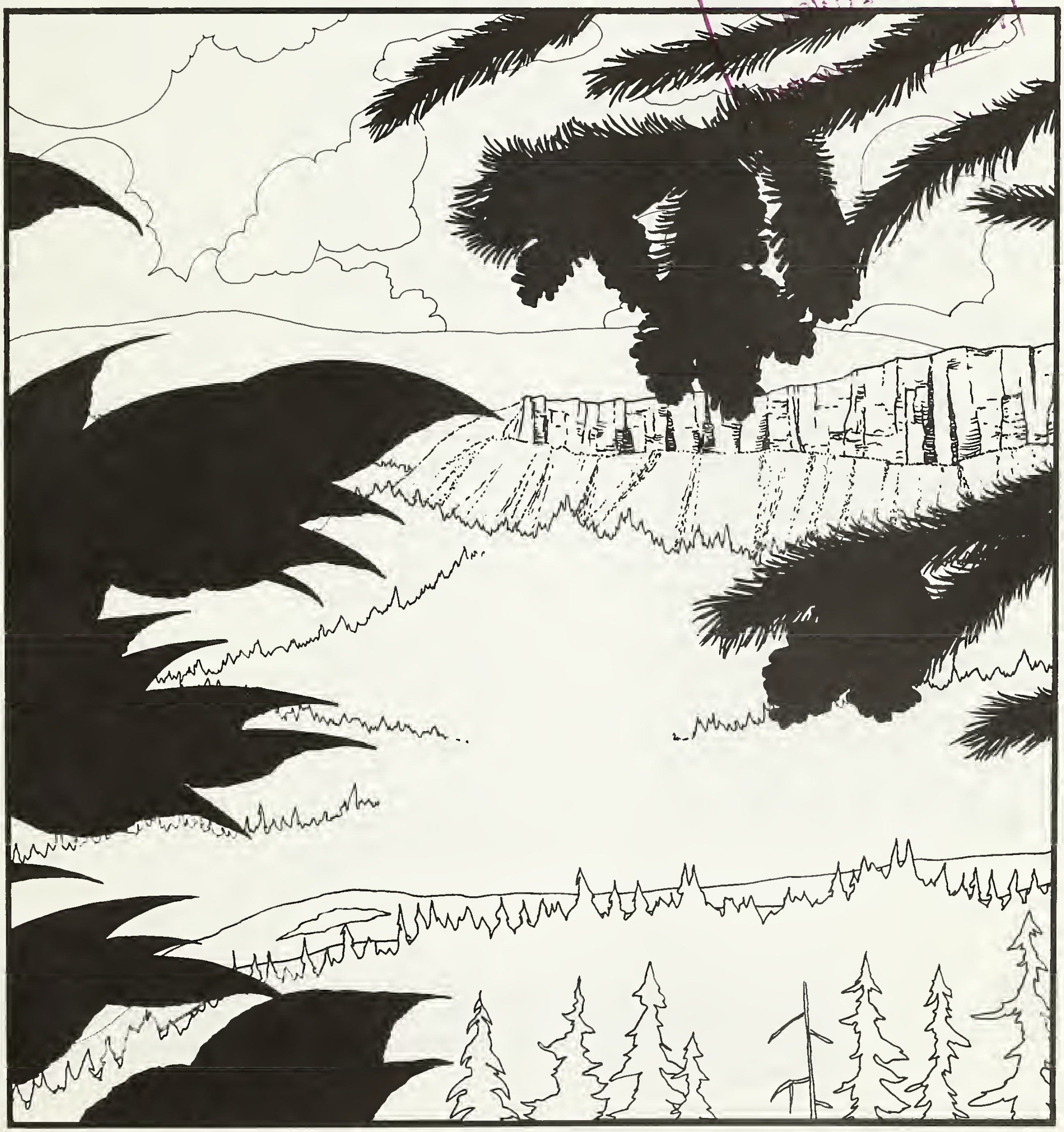
Pacific Northwest
Research Station

Research Paper
PNW-RP-401

September 1988

Twig and Foliar Biomass Estimation Equations for Major Plant Species in the Tanana River Basin of Interior Alaska

John Yarie and Bert R. Mead



Authors

JOHN YARIE is an assistant professor of Silviculture, University of Alaska, Fairbanks, Alaska 99775-5500. BERT R. MEAD is a forester, Forestry Sciences Laboratory, Pacific Northwest Research Station, 201 East Ninth Avenue, Suite 303, Anchorage, Alaska 99501.

Preface

Forest Inventory and Analysis (FIA) is a nationwide project of the USDA Forest Service authorized by the Forest and Rangeland Renewable Resources Research Act of 1978. Work units of the project, located at Forest Service Experiment Stations, conduct forest inventories throughout the 50 United States. The Pacific Northwest Research Station at Portland, Oregon, is responsible for forest inventories in Alaska, California, Hawaii, Oregon, and Washington.

Abstract

Yarie, John; Mead, Bert R. 1988. Twig and foliar biomass estimation equations for major plant species in the Tanana River Basin of interior Alaska. Res. Pap. PNW-RP-401. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 20 p.

Equations are presented for estimating the twig, foliage, and combined biomass for 58 plant species in interior Alaska. The equations can be used for estimating biomass from percentage of foliar cover of 10-centimeter layers in a vertical profile from 0 to 6 meters. Few differences were found in regressions of the same species between layers except when the ratio of foliar-to-twig biomass changed drastically between layers; for example, *Rosa acicularis* Lindl. Eighteen species were tested for regression differences between years. Thirteen showed no significant differences; five were different. Of these five, three were feather mosses for which live and dead biomass are easily confused when measured.

Keywords: Biomass equations, Alaska (interior), Alaska (Tanana Valley), inventory (wildlife habitat).

Research Summary

This study was undertaken to develop biomass equations from foliar cover and height estimates taken in the field. The equations will provide efficient and labor-saving means for determining vegetative biomass on inventory plots. The equations that were developed predict total aboveground biomass for lichens, mosses, grasses, and forbs. Shrub and tree equations are used for predicting biomass of leaves and of twigs and stems up to 5 millimeters in diameter, the approximate browsing limit. Estimates developed from these equations will be applied to Alaska inventory data for evaluating wildlife-habitat potential.

Equations for estimating biomass of 58 plant species found in interior Alaska are presented. The equations can be used for estimating biomass from foliar cover for 10-centimeter layers in a vertical profile from 0 to 6 meters. When compared, very few differences were found in regressions of the same species between layers except when the ratio of foliar-to-twig biomass changed drastically between layers; for example, *Rosa acicularis* Lindl. Eighteen species were tested for yearly regression differences. Thirteen showed no significant differences; five were different. Of these five, three were feather mosses for which live and dead biomass are easily confused when measured.

Contents

Background

The importance of biomass estimates for both timber and nontimber resources has been nationally recognized in recent years. In 1980, the USDA Forest Service did a state-of-the-art national tree biomass compilation (U.S. Department of Agriculture 1981). Summaries of Alaska's estimated timber biomass were published in conjunction with the national compilation (Yarie and Mead 1982), and timber biomass tables have been incorporated into river basin resource reports (Setzer 1987). Biomass estimates and equations for lesser vegetation have also been published for other areas of the United States and Canada (Smith and Brand 1983; Stanek and State 1978; Phillips 1981). Because biomass estimates provide one way of assessing land for browse, forage, and potential wildlife productivity, biomass assessment should be particularly useful in interior Alaska where some lands are currently valued more as wildlife habitat than for lumber production.

The first extensive inventories of lesser vegetation in Alaska were accomplished by multiagency cooperative efforts in the Porcupine and Susitna River basins from 1978 to 1981 (Setzer 1984; U.S. Department of Agriculture 1986). Understory measurement in the Susitna River basin was directed at herbage and browse production rather than biomass estimation. Annual production was estimated by a double-sampling, clip-and-weigh technique at each sample plot. It was soon discovered that annual production estimates based on plant weights from inventory plots spread over a large area were of questionable value because plants on one plot may be newly emergent, and plants on another plot measured the same day but at a different elevation may have been fully developed and bearing fruit. This problem is evident even in areas of the same elevation but of different latitudes or having different aspect. Such pronounced differences are probably the result of Alaska's short, compressed growing season.

Funding and high-transportation costs precluded remeasuring plots throughout the growing season to correct for phenological changes. To obtain accurate estimates at reasonable costs, we decided to add biomass estimates to the Alaska Integrated Resource Inventory System (AIRIS) developed by the Forest Inventory and Analysis work unit and used throughout Alaska for vegetation inventory. We also decided to adapt the horizontal-vertical (HV) vegetation profile system (McClure and others, 1979) developed in the Southeastern United States for use in Alaska and to use larger plots (100 square meters) that would capture more of the scattered tall shrubs often missed on the 3.048- by 3.048-meter (10 x 10 foot) plots used previously.

The horizontal-vertical vegetation profile was developed as a quick-and-easy method for describing all vegetation on inventory plots. The profiles are developed by appraisal of the vegetation and its natural vertical layering at each inventory site. Definite layers are normally apparent; usually ground cover grows below low and tall shrubs, each in distinct layers. On forest plots, an additional overstory canopy layer exists. When a species overlaps into two or more layers, its abundance can be described with two or more estimates of foliar cover, one for each layer.

Every plant species on the HV plot was described with the following methods: The vegetation is divided into layers; and for each layer, a bottom height and top height are recorded. Then, the percentage of foliar cover for all plants in the layer is estimated. Each plant species is listed next, and an estimate is made of the percentage of foliage occupying the layer. An example of the data form for this procedure is shown in figure 1. For the subjective estimates to apply, training and quality control are necessary to get consistency between observers and between different vegetation types. Under these conditions, field experience has shown that the subjective estimates of cover can be highly consistent.

The potential value and use of vegetation profile descriptions has been described by McClure and others (1979), Cost (1979) and Lennartz and McClure (1979). Sheffield (1981) demonstrated procedures for evaluating forest land breeding habitats for individual nongame bird species and entire avian communities in part by describing cover and occurrence of plant layers. Vegetation profile and biomass data were shown to be useful by Craver (1982), when he estimated honeysuckle distribution in South Carolina. Honeysuckle, an introduced vine, creates major management problems by competing for light and nutrients with forest trees. Knowledge of its distribution contributes to the control of the honeysuckle.

Descriptions of nontimber vegetation cover and biomass are particularly important in Alaska where wildlife habitat values often overshadow timber resource values. These descriptions can be used in establishing a baseline of vegetation before rapidly developing areas of the State are impacted by major construction activities.

Because the new AIRIS inventory system used plots spread over 20 acres (8 hectares), data collection needed to be quick and efficient; hence, biomass needed to be estimated without plant weight, which is time consuming to measure. To develop such equations, we conducted this study with the objective of utilizing foliar cover and layer-height estimates made on the horizontal-vertical profile plots to predict biomass. A further goal of this study was to develop the equations in such a way that they would apply to the range of vegetation types found in the Tanana River basin. The 100-square-meter (5.67-meter-radius, 18.6-feet-radius) HV plots, however, proved too large for equation development; therefore, we used smaller 0.55-square-meter plots. We recognized that the layer height might be different on these smaller plots, so we arbitrarily defined vertical layers as 0.10 meter (.33 ft), enabling the equations to apply to the layer heights defined on the HV plots. Field crews, unfortunately, had to break plots into more layers instead of lumping plants into general height classes. This was more time consuming yet not as costly as clipping and weighing each plant.

Five primary communities were studied the 1st year (1982) of the 2-year study: black spruce forest, white spruce forest, tall willow shrub, tall alder shrub, and birch-aspen forest. The second year, (1983) five additional communities were targeted: dwarf birch/willow shrub, calamagrostis grassland, sedge/grass, herbaceous, and moss/lichen. A more complete description of these types can be found in Viereck and Dyrness (1980). These communities covered the most prevalent types of vegetation in the Tanana River basin.

	HV profile (layer)						
	1	2	3	4	5	6	7
			(Decimeters)				
Begins at this height	000	000	[001][a]	003	010	015	020
Top is at this height	000	001	[003]	010	015	020	024
			(Percent)				
Layer foliar cover	100	065	[035]	045	025	010	002

Species	Percent composition by species within layer						
Barren ground	006						
Hylocomium splendens	080						
Aulacomnium	002						
Cladonia	010						
Vaccinium vitis-idaea	002	055					
Geocaulon lividum	---	005	002				
Epilobium angustifolium	---	005	007	002			
Calamagrostis canadensis	---	020	030	040	060		
Mertensia paniculata	---	003	002	011			
Equisetum arvense	---	008	016				
Betula papyrifera	---	001	001	001	010	040	030
Populus tremuloides	---	001	002	004	015	060	070
Betula nana	---	---	[015]	040	015		
Ledum groenlandicum	---	002	025	002			
TOTAL	100	100	100	100	100	100	100

[a] Brackets indicate table values used in the following example.

An example of the application of the biomass coefficients for *Betula nana* follows:

1. Look up the biomass coefficient in table 6. It is 10.15 for foliage and twigs combined.

2. Compute the number of 1-decimeter (dm) sublayers in layer 3 (the first layer occupied by *Betula nana*) by subtracting the beginning height from the top height: (003 - 001) = 2 dm.

3. Compute percent foliar cover of *Betula nana* by multiplying the percent foliar cover of the layer by the percent composition of the layer occupied by *Betula nana*: (0.35) (0.15) = 0.0525 = 5.25 percent.

4. Compute biomass for layer 3 by multiplying the vertical extent of layer computed in step 2 by the percent foliar cover of *Betula nana* by the biomass coefficient: (2 dm) (5.25) (10.15) = 106.58 kg ha^{-1}.

5. Compute biomass for layer 4: (010 dm - 003 dm) [(0.45)(0.401 (100)] (10.15 kg $ha^{-1}dm^{-1}$) = 1,282.10 kg ha^{-1}.

6. Compute biomass for layer 5: (015 dm - 010 dm) [(0.25)(0.15)(100)] (10.15 kg $ha^{-1}dm^{-1}$) = 190.31 kg ha^{-1}.

7. Add biomass for layers 3, 4, and 5: 106.58 + 1,282.10 + 190.31 = 1,579 kg ha^{-1} of *Betula nana*, excluding stems $\geq$5.0 mm in diameter.

Figure 1—An example of the horizontal-vertical (HV) profile data form and how to apply biomass coefficients to the HV data.

Methods for Equation Development

Field sampling was done with a technique similar to that of Harcombe and Marks (1977). Ropes were hung from an aluminum stepladder to define a vertical profile. The ropes were color coded to delineate 0.305 meter levels. The plot surface area was 0.56 square meter (0.61 by 0.91 meter; 2×3 ft) so that each vertical level represented 0.17 cubic meter.

The ground level (level g) was sampled on a 0.093-square-meter subplot. This sample included all mosses, lichens, and any other small plant that generally would not exceed 2.5 centimeters (1 in) in height when fully grown. Ground-level estimates, therefore, were based on a surface-area measurement rather than a volume measurement.

A random starting point was selected in each sample stand; plots were then located along a transect 120 meters long with 20 meters between plots. Additional samples were taken along a second line parallel to and 50 meters distant from the first. Twig and foliar cover was estimated by species from the highest vertical level and working downward.

Because of the possibility of bias in estimation of the foliar cover by different people, frequent checks were made between the field people who obtained the biomass information and the inventory crews who worked on the HV plots. Consistent results in estimates of foliar cover percentages were obtained from these checks. After foliar cover was estimated, the material hanging within the plot was clipped. Only twigs less than 5 millimeters in diameter were clipped because this was the approximate maximum sized twig that wildlife will browse. For the low shrubs that never have twigs larger than 5 millimeters, the total aboveground plant was clipped. The samples were placed in paper bags and returned to the lab for drying at 65 °C; the dry weight of leaves and twigs was measured separately. A conditioned regression equation was used to define the relation between the foliar cover and biomass:

$$y = aC ;$$

where

y = measured biomass of leaves, twigs, or combined leaves and twigs;
C = estimated foliar cover (percentage); and
a = regression coefficient.

A dummy variable analysis (Cunia 1973) was used to test for differences between the slope of equations for different layers within a community and then between communities for layers or groups of layers that were similar within communities. A t-test was used to test the equality of regression slopes from equations developed in different years.

Results and Discussion

Equations were developed for a total of 58 species or groups of species; (such as, *Hepatica* Hill.) (tables 1-7). Most equations had an r^2 greater than 0.8 (range 0.62 to 0.999). Equations were developed for both leaf and twig weight plus a combined weight. The twig-weight regressions were less accurate than the leaf-weight or combined-weight equations in all cases. Inaccuracy was expected because the relation of foliar-cover to the amount of twig material is difficult to estimate, and small changes in twig orientation to a horizontal plane can greatly affect the relation between foliar-cover percentage and twig biomass.

Table 1—Coefficients for predicting the total aboveground dry biomass (kilograms per hectare) from percentage of cover in the ground layer for lichen species

Species[a]	Plots	Biomass coefficient	r^2	Maximum cover	Standard error	Communities sampled
	number			*percent*	*kg/ha*	
Cetraria cucullata, fruticose lichen	6	4.77	0.91	10	9.61	Woodland dwarf tree scrub Closed dwarf tree scrub
Cetraria islandica, Iceland "moss"	6	5.63	0.90	7	7.71	Woodland dwarf tree scrub Closed dwarf tree scrub Calamagrostis grassland
Cladina spp., reindeer lichen	15	7.41	0.89	45	47.39	Open black spruce forest Woodland dwarf tree scrub Closed dwarf tree scrub Calamagrostis grassland
Cladonia spp., cup-stalk lichen	28	4.32	0.80	4	2.06	Closed white spruce forest Open black spruce forest Closed paper birch forest
Peltigera spp., veined lichen	29	4.98	0.96	5	1.31	Closed white spruce forest Closed spruce-birch forest Open black spruce forest
Peltigera apthosa, veined lichen	11	15.21	0.93	30	14.76	Open black spruce forest Open paper birch forest Open dwarf tree scrub Closed dwarf tree scrub
Stereocaulon spp., rock lichen	6	4.76	0.94	99	202.19	Closed dwarf tree scrub Dryas tundra

[a] Common and scientific names with authorities are listed in the appendix.

Table 2—Coefficients for predicting total aboveground dry biomass (kilograms per hectare) from percentage of cover in the ground layer for moss species

Species[a]	Plots	Biomass coefficient	r^2	Maximum cover	Standard error	Communities sampled
	number			*percent*	*kg/ha*	
Aulacomnium spp., bog moss	9	4.73	0.94	60	37.4	Open dwarf tree scrub Woodland dwarf tree scrub Closed dwarf tree scrub
Brachythecium spp., small capsule moss	10	3.61	0.83	20	4.7	Closed paper birch forest
Dicranum spp., broom moss	14	7.29	0.95	50	25.1	Closed white spruce forest Closed paper birch forest Closed spruce-birch forest Open black spruce forest Open dwarf tree scrub Woodland dwarf tree scrub Closed dwarf tree scrub
Hepatica, liverworts	8	1.79	0.80	10	16.6	Closed white spruce forest Closed dwarf tree scrub Calamagrostis grassland
Hylocomium splendens, stair-step moss	35	2.20	0.77	100	70.0	Closed white spruce forest Closed black spruce forest Closed paper birch forest Woodland dwarf tree scrub Open willow
Hypnum spp., moss	10	2.51	0.99	75	6.8	Closed spruce-birch forest
Pleurozium schreberi, Schreber's moss	44	3.52	0.76	100	116.3	Closed white spruce forest Closed black spruce forest Open paper birch forest Open black spruce forest Open dwarf tree scrub Woodland dwarf tree scrub Closed dwarf tree scrub Closed dwarf birch shrub Calamagrostis grassland
Polytrichum juniperinum, juniper moss	14	3.92	0.89		6.3	Closed black spruce forest Woodland dwarf tree scrub Closed dwarf tree scrub Calamagrostis grassland
Rhytidiadelphus triquetrus, shaggy moss	10	2.32	0.94	90	25.1	Closed white spruce forest
Sphagnum spp., sphagnum moss	19	4.76	0.93	99	83.1	Open black spruce forest Open dwarf tree scrub Woodland dwarf tree scrub Open dwarf tree scrub Calamagrostis grassland

[a] Common and scientific names with authorities are listed in the appendix.

Table 3—Coefficients for predicting the total aboveground dry biomass (kilograms per hectare) for 10-centimeter layers of grass and grasslike species

Species[a]	Level[b] sampled	Plots	Biomass coefficient	r^2	Maximum cover	Standard error	Communities sampled
		number			*percent*	*kg/ha*	
Calamagrostis canadensis, bluejoint grass	1-3	82	2.38	0.74	65	20.4	Closed white spruce forest Closed spruce-birch forest Open black spruce forest Closed paper birch forest Open paper birch forest Closed dwarf tree scrub Woodland dwarf tree scrub Open willow shrub Closed dwarf birch shrub Calamagrostis grassland
Carex spp., sedge	1-2	19	2.92	0.96	80	13.5	Open black spruce forest Closed dwarf tree scrub Open willow
Carex aquatilis, water sedge	1-2	7	4.56	0.63	15	33.7	Closed dwarf tree scrub Open willow
Carex bigelowii, bigelow sedge	1	19	2.28	0.82	35	13.3	Closed dwarf tree scrub Open dwarf tree scrub Woodland dwarf tree scrub Calamagrostis grassland
Eriophorum vaginatum, tussock cottongrass	1	9	3.70	0.94	65	30.2	Closed dwarf tree scrub Open dwarf tree scrub Calamagrostis grassland

[a] Common and scientific names with authorities are listed in the appendix.

[b] The 3-decimeter level sampled is indicated. Level 1 is 0 to 0.3 meter; 2 is 0.3 to 0.6 meter; and so forth.

Table 4—Coefficients for predicting the total aboveground dry biomass (kilograms per hectare) for 10-centimeter vertical layers for forbs and low woody plants

Species[a]	Level[b] sampled	Plots	Biomass coefficient	r^2	Maximum cover	Standard error	Communities sampled
		number			*percent*	*kg/ha*	
Cornus canadensis, bunchberry	1	49	1.48	0.85	60	11.3	Closed white spruce forest Closed black spruce forest Closed paper birch forest Closed spruce-birch forest
Dryas drummondii, drummond mountain-avens	g	9	1.81	0.97	95	20.1	Dryas tundra
Empetrum nigrum, crowberry	g	13	2.41	0.90	35	12.3	Closed dwarf tree scrub Woodland dwarf tree scrub Open dwarf tree scrub Open willow shrub
Epilobium angustifolium, common fireweed	1	8	3.50	0.89	15	9.7	Closed black spruce forest Open paper birch forest Closed dwarf tree scrub Closed alder-willow shrub Closed dwarf birch shrub
Equisetum arvense, field horsetail	2	61	1.28	0.87	95	16.1	Closed white spruce forest Open black spruce forest Closed paper birch forest Open paper birch forest Closed spruce-birch forest Open willow shrub
Equisetum variegatum, variegated scouring rush	1	12	7.09	0.91	25	33.5	Closed alder-willow shrub
Geocaulon lividum, northern commandra	1	30	1.88	0.80	6	4.1	Closed white spruce forest Closed black spruce forest
Linnea borealis, twin-flower	g	38	3.29	0.81	60	25.8	Closed white spruce forest Closed paper birch forest Closed spruce-birch forest
Louiseleuria procumbens, alpine azalea	g	6	6.76	0.89	30	48.5	Closed dwarf tree scrub Mat and cushion tundra
Mertensia paniculata, tall bluebell	g	17	0.96	0.99	25	0.1	Closed white spruce forest
Pyrola spp., wintergreen	1	19	4.30	0.99	20	0.9	Closed white spruce forest Closed paper birch forest
Pyrola grandiflora, large-flowered wintergreen	1	9	2.94	0.99	2	0.2	Closed white spruce forest
Pyrola secunda, one-sided wintergreen	1	30	3.79	0.87	5	1.8	Closed white spruce forest Closed paper birch forest Closed dwarf tree scrub
Rubus chamaemorus, cloudberry	1	11	1.86	0.61	7	7.7	Open black spruce scrub Woodland dwarf tree scrub Calamagrostis grassland
Vaccinium vitis-idaea, mountain cranberry	g	68	2.23	0.90	80	18.2	Closed white spruce forest Closed black spruce forest Open black spruce forest Closed paper birch forest Open paper birch forest Closed dwarf tree scrub Open dwarf tree scrub Woodland dwarf tree scrub Closed alder-willow shrub Calamagrostis grassland

[a] Common and scientific names with authorities are listed in the appendix.

[b] The 3-decimeter level sampled is indicated. Level g is ground layer; 1 is 0 to 0.3 meter; 2 is 0.3 to 0.6 meter.

Table 5—Coefficients for predicting leaf, twig, and combined dry biomass (kilograms per hectare) for 10-centimeter vertical layersfor low shrub species

Species[a]	Plant component	Level[b] sampled	Plots	Biomass coefficient	r^2	Maximum cover	Standard error	Communities sampled
			number			*percent*	*kg/ha*	
Ledum groenlandicum,	Leaf	1-2	28	2.49	0.84	65	28.5	Closed black spruce forest
Labrador tea	Stem <5 mm	1-2	28	5.74	0.89		52.4	Open paper birch forest
	Combined	1-3	28	8.23	0.92		61.1	Closed dwarf tree scrub
								Open dwarf tree scrub
								Woodland dwarf tree scrub
								Closed dwarf birch shrub
								Calamagrostis grassland
Ledum palustre,	Leaf	1	33	3.83	0.86	55	35.7	Open black spruce forest
northern Labrador tea	Stem <5 mm	1	33	6.49	0.80		74.9	Closed dwarf tree scrub
	Combined	1	33	10.32	0.85		102.1	Open dwarf tree scrub
								Woodland dwarf tree scrub
								Calamagrostis grassland
Potentilla fruticosa,	Leaf	1-2	7	2.02	0.99	7	.9	Open willow shrub
bush cinquefoil	Stem <5 mm		7	8.93	0.73		26.5	
	Combined		7	10.95	0.81		26.0	
Ribes triste,	Leaf	1-2	29	0.94	0.93	20	1.25	Closed white spruce forest
American red currant	Stem <5 mm		29	2.51	0.77		6.66	Closed spruce-birch forest
	Combined		29	3.45	0.83		7.76	
Rosa acicularis,	Leaf	1-6	149	0.81	0.68	75	9.09	Closed white spruce forest
prickly rose	Stem <5 mm		149	1.39	0.45		25.44	Closed black spruce forest
	Combined		149	2.20	0.63		27.72	Closed paper birch forest
								Open paper birch forest
								Closed spruce-birch forest
Shepherdia canadensis,	Leaf	1	5	1.90	0.85	65	43.3	Closed black spruce forest
russet buffaloberry	Stem <5 mm	1-3	5	4.30	0.92		67.9	Woodland dwarf tree scrub
	Combined		5	6.20	0.95		79.8	
Vaccinium uliginosum,	Leaf	1-2	50	1.94	0.91	95	20.5	Closed black spruce forest
bog blueberry	Stem <5 mm		50	9.70	0.88		123.2	Open paper birch forest
	Combined		50	11.64	0.90		133.7	Closed dwarf tree scrub
								Open dwarf tree scrub
								Woodland dwarf tree scrub
								Closed dwarf birch shrub
								Calamagrostis grassland
Viburnum edule,	Leaf	1-3	70	2.10	0.96	20	1.4	Closed white spruce forest
highbush cranberry	Stem <5 mm		70	2.19	0.89		2.3	Closed paper birch forest
	Combined		70	4.29	0.95		2.9	Closed spruce-birch forest

[a] Common and scientific names with authorities are listed in the appendix.

[b] The 3-decimeter level sampled is indicated. Level 1 is 0 to 0.3 meter; 2 is 0.3 to 0.6 meter; and so forth.

Table 6—Coefficients for predicting leaf, twig, and combined dry biomass (kilograms per hectare) for 10-centimeter vertical layers for tall shrub species

Species[a]	Plant component	Level[b] sampled	Plots	Biomass coefficient	r^2	Maximum cover	Standard error	Communities sampled
			number			*percent*	*kg/ha*	
Alnus crispa, American green alder	Leaf	1-16	131	1.84	0.86	90	16.8	Closed white spruce forest
	Twig <5 mm	1-4	131	2.66	0.81		29.6	Closed black spruce forest
	Combined		131	4.50	0.86		41.3	Closed paper birch forest
								Closed spruce-birch forest
								Woodland dwarf tree scrub
								Open willow shrub
Alnus tenuifolia, thinleaf alder	Leaf	1-7	33	2.33	0.85	60	17.5	Closed white spruce
	Twig <5 mm	1-7	33	2.10	0.77		21.0	Closed alder-willow shrub
	Combined	1-7	33	4.43	0.84		34.6	Open willow shrub
Betula glandulosa, resin birch	Leaf	1-3	33	1.90	0.89	80	21.2	Closed dwarf tree scrub
	Twig <5 mm	1-3	33	7.11	0.88		79.6	Woodland dwarf tree scrub
	Combined	1-3	33	9.00	0.92		79.9	Closed dwarf birch shrub
Betula nana, arctic birch	Leaf	1-2	34	3.02	0.90	65	20.2	Open black spruce forest
	Twig <5 mm	1-3	34	7.13	0.79		74.3	Closed dwarf tree shrub
	Combined	1-3	34	10.15	0.83		92.1	Closed dwarf birch shrub
Betula occidentalis, water birch	Leaf		7	3.49	0.94	35	18.8	Closed dwarf tree scrub
	Twig <5 mm		7	3.68	0.97		14.9	Closed dwarf birch shrub
	Combined		7	7.17	0.96		28.9	
Salix alaxensis, feltleaf willow	Leaf	1-7	65	4.08	0.92	80	23.1	Closed alder-willow shrub
	Twig <5 mm	1-7	65	2.38	0.80		22.5	Open willow shrub
	Combined		65	6.45	0.95		28.9	
Salix bebbiana, bebb willow	Leaf	3	41	2.18	0.87	80	26.2	Closed black spruce forest
	Twig <5 mm	1-7	41	2.21	0.85		29.2	Closed dwarf tree scrub
	Combined		41	4.39	0.88		50.4	Closed alder-willow shrub
								Closed dwarf birch shrub
Salix glauca, grayleaf willow	Leaf	1-3	5	3.88	0.91	10	7.4	Closed dwarf tree scrub
	Twig <5 mm		5	4.83	0.95		6.6	
	Combined		5	8.70	0.98		7.7	
Salix novae-angliae, tall blueberry willow	Leaf	1-3	21	3.66	0.93	10	5.5	Closed black spruce forest
	Twig <5 mm		21	6.63	0.65		23.1	
	Combined		21	10.14	0.79		24.0	
Salix planifolia, ssp. *pulchra* diamondleaf willow	Leaf	1-3	24	2.44	0.91	10	17.3	Closed dwarf tree scrub
	Twig <5 mm		24	4.54	0.93		5.4	Open dwarf tree scrub
	Combined		24	6.98	0.96		33.1	Open willow shrub

[a] Common and scientific names with authorities are listed in the appendix.

[b] The 3-decimeter level sampled is indicated. Level 1 is 0 to 0.3 meter; 2 is 0.3 to 0.6 meter, and so forth.

Table 7—Coefficients for predicting leaf, twig, and combined dry biomass (kilograms per hectare) for a 10-centimeter vertical layer of trees

Species[a]	Plant component	Level[b] sampled	Plots	Biomass coefficient	r^2	Maximum cover	Standard error	Communities sampled
			number			*percent*	*kg/ha*	
Picea glauca, white spruce	Leaf	1-4	40	14.15	0.99	12	2.87	Closed black spruce
	Twigs <5 mm		40	5.87	0.99		2.29	
	Combined		40	20.02	0.97		4.87	
Picea mariana, black spruce	Leaf	1-16	26	11.85	0.82	60	93.8	Closed black spruce
	Twigs <5 mm		6	5.87	0.88		36.7	Closed dwarf tree scrub
	Combined		26	17.64	0.86		123.9	Open dwarf tree scrub
Populus balsamifera, balsam poplar	Leaf	1-2	21	4.30	0.97	20	4.7	Closed alder-willow
	Twigs <5 mm		21	5.04	0.95		6.8	Dryas tundra
	Combined		21	9.33	0.98		7.8	

[a] Commom and scientific names with authorities are listed in the appendix.

[b] The 3-decimeter level sampled is indicated. Level 1 is 0 to 0.3 meter; 2 is 0.3 to 0.6 meter; and so forth.

The equations presented in tables 1-7 estimate biomass over a layer 1 hectare in surface area and 10 centimeters high. Equations that were developed from as few as five sample values were included to cover as broad a range of species as possible. Ten to twenty values collected from several communities would have likely resulted in a better estimate of the natural variability. The predictive equation that we applied to the horizontal-vertical plots is:

$$y = \sum_{i=1}^{L} \sum_{n=1}^{h_i} [(\text{coefficent})\ (C_n)] \ ;$$

where,

y = predicted biomass;
L = number of layers of H/V plot;
h_i = number of decimeter sublayers in the layer "i"; and
C_n = percent cover of layer "i."

Most shrub species that displayed vertical development (for example, *Rosa acicularis* Lindl.) were found to have significantly different equations at the first or second vertical levels (table 8), the different equations existed because more twigs are located at the first and second levels than at other levels. Variation in amount of twigs at different vertical levels occurs only in communities where shrubs show distinct layering.

Table 8—Community and layer analysis for *Rosa acicularis*, 1982 data[a]

Plant component	Similar communities	Similar levels[b]	Biomass coefficient	r^2
Leaf	Closed spruce-birch forest	1-6	0.81	0.69
	Closed white spruce forest	1-4		
	Closed paper birch forest	1-3		
Stem	Closed spruce-birch forest	3-6	1.06	0.68
	Closed white spruce forest	1-4		
	Closed paper birch	1-3		
Combined	Closed spruce-birch forest	3-6	1.86	0.77
	Closed white spruce forest	1-4		
	Closed paper birch forest	1-3		
Stem	Closed spruce-birch forest	2	6.68	—
Combined	Closed spruce-birch forest	2	7.54	—
Stem	Closed spruce-birch forest	1	3.28	—
Combined	Closed spruce-birch forest	1	4.14	—

— = not available.

[a] Coefficients are presented by component for statistically equal plant communities and vegetation levels. The stem and combined coefficients for levels 1 and 2 of the closed spruce-birch forest could not be combined with the coefficients for the other levels and communities without significantly increasing the residual variance. Equations predict plant component biomass (y) in kilograms per hectare dry weight for a 10-centimeter vertical layer.

[b] The 3-decimeter level sampled is indicated. Level 1 is 0 to 0.3 meter; 2 is 0.3 to 0.6 meter, and so forth.

Very few differences between community types existed. The only species that showed community differences were *Cornus canadensis* L., *Hylocomium splendens* (Hedw.) B.S.G., *Pleurozium schreberi* (Brid.) Mitt., and *Rosa acicularis*. Differences between the communities may be related to the time of the year when samples were collected from the four species; the data were not collected to test for differences in the leaf area-to-weight ratio throughout the sampling period. Also, community differences for the two moss species, *Hylocomium splendens* and *Pleurozium schreberi*, may be related to the vertical development of the moss layer and the difficulty in distinguishing live from dead tissue. The four species need further study before separate equations can be developed for different community types. Users of the equations presented here for these four species should remember that, although significant, better equations could be developed for considering community differences.

Eighteen species sampled in both years (1982, 1983) were tested for differences in regression slopes between years. Five of the species showed significant differences between years: *Aulacomniun* spp. *Schwaegr.*, *Hylocomium splendens*, *Ledum groenlandicum* (Oeder), *Picea mariana* (Mill.) B.S.P., and *Pleurozium schreberi*. Three of the species that showed yearly differences were feather mosses; differences may have resulted from sampling error.

Table 9—Regression coefficients for 6 genus groups[a]

Genus	Plant part	Biomass coefficient	r^2	Maximum cover	Standard error	Plots
				percent	*kg/ha*	*number*
Alnus	Leaf	1.91	0.86	90	17.3	164
	Twigs <5 mm	2.58	0.80		28.3	164
	Combined	4.47	0.86		40.3	164
Betula	Leaf	2.32	0.85	80	25.1	74
	Twigs <5 mm	6.91	0.84		75.6	74
	Combined	9.18	0.89		82.5	74
Carex	Total	2.85	0.87	80	20.5	39
Equisetum	Total	1.46	0.60	95	42.3	67
Ledum	Leaf	3.83	0.86	65	35.3	66
	Twigs <5 mm	6.49	0.80		74.3	66
	Combined	10.32	0.85		101.3	66
Salix	Leaf	2.83	0.82	80	28.7	144
	Twigs <5 mm	2.33	0.77		27.1	144
	Combined	5.16	0.87		42.9	144

[a] Coefficients predict dry biomass in kilograms per hectare of plant component for a 10-centimeter vertical layer.

No yearly differences were shown for the following tested species:

Alnus crispa (Ait.) Pursh
Alnus tenufolia (Nutt.) Breitung
Betula nana L.
Calamagrostis canadensis (Michx.) Beauv.
Carex L. spp.
Cladina spp.
Dicranum Hedw. spp.
Hepatica spp.
Ledum palustre
Rubus chamaemorus L.
Sphagnum L. spp.
Vaccinium uligonosum L.
Vaccinium vitis-idaea L.

A final group of coefficients was developed, combining several species into genus groups. The genus group coefficients were for *Alnus*, *Betula*, *Carex*, *Equisetum*, *Ledum*, and *Salix* (table 9). Several of the individual species regressions were significantly different (table 1-7), so the user must choose between the individual species or the grouped genus regressions.

Comparison of Foliar Cover Plots With Biomass Plots

A comparison of results from the inventory vegetation profile system and the direct estimate of understory twig-and-foliar biomass was made on three of the sample stands (figs. 2-4). In general, both estimates were in agreement. The differences that did exist can be ascribed, in part, to the different plot sizes used to obtain the two estimates. The inventory sample was based on percentage of foliar cover in a 100-square-meter plot (fig. 4). The biomass estimates were obtained from a 0.56-square-meter plot that, because of its small size, may not have included species rare to the stand. Unless a large number of plots were sampled, these rare species may have been missed. As an example, the closed spruce-birch stand sampled on the Chena Hot Springs Road had a few scattered alder. The biomass sample, however, resulted in no alder sampled and showed fewer shrubs than in the inventory sample in levels that were above 1 meter.

```
Height                                   Foliar cover plot
(meters)

6.5   c
6.0   c s
5.5   c s
5.0   s s s s s s s s s s s s s s s
4.5   s s s s s s s s s s s s s s s
4.0   s s s s s s s s s s s s s s s
3.5   s s s s s s s s s s s s s s s
3.0   s s s s s s s s s s s s s s s s s s s s s s s s s
2.5   s s s s s s s s s s s s s s s s s s s s s s s s s s s s s s s s s s
2.0   s s s s s s s s s s s s s s s s s s s s s s s s s s s s s s
1.5   s s s s s s s s s s s s s s s s s s s s s s s s s s s s s
1.0   s s s s s s s s s s s s s s s s s s s s s s s s s s f
0.5   m m m m m m m m m m m m m m s s s s s s s s s s s s s s s s s s s f f f f f f f f
                        10                  20                  30                  40
                          Percent foliar cover
```

```
Height                               Biomass plot
(meters)

4.8   s s s s s s s s s
4.5   s s s
4.2   s s s s s s s s s
3.9   s s s s s s s
3.6   s s s s s s s s s s s s s s s s s s s s s s
3.3   s s s s s s s s s s s s s
3.0   s s s s s s s s s s s s s s s s s s s s
2.7   s s s s s s s s s s s s s s s s
2.4   s s s s s s s s s s s s s s s s
2.1   s s s s s s s s s s s s s
1.8   s s s s s s s s s s s
1.5   s s s s s
1.2   s s s s s s s
0.9   s s s s s s
0.6   g f s s s s s s s
0.3   g m m m m m m m m m m m m m m m m m m m f f f f f f f f f f f f f f f f s s s s s s
                        10                  20                  30                  40
                         Biomass (grams per square meter)
```

```
Key:  c = conifer tree        g = grass
      b = broadleaf tree      m = moss
      s = shrub               l = lichen
      f = forb                o = other
```

Figure 2—Vegetation profile with both percentage of foliar cover (data from horizontal-vertical description plot) and sampled biomass for a closed white spruce community on Willow Island.

```
Height                          Foliar cover plot
(meters)

6.5
6.0    s s s
5.5    s s s
5.0    c s s s s s
4.5    c s s s s s
4.0    c c c c c s s s s s s s s s s s
3.5    c c c c c s s s s s s s s s s s
3.0    c c c c c s s s s s s s s s s s
3.5    c c c c c s s s s s s s s s s s s s
2.0    c c s s s s s s s s s
1.5    c c s s s s s s s s s
1.0    c s s s s s s s s s s s s s s s s g f f
0.5    m s s s s s s s s s s s s s s s s s s g g g g g f f f f f
                        10                  20                 30

                   Percent foliar cover
```

```
Height                          Biomass plot
(meters)

4.2    s
3.9    s
3.6    s s s s s s
3.3    s s s s s s s s s s s s s
3.0    s s s s s s s s
2.7    s s s s s s s s s s s s s s s s
2.4    s s s s s
2.1    s s s s s
1.8    s s
1.5    s
1.2    s s s
0.9    f g s s s s s
0.6    g g s s f
0.3    1 m m g g g g g g s s s s s s s s s s s s s s s s f f f f f f f f f f f f f f f f f
                         10                  20                  30                  40

                   Biomass (grams per square meter)
```

```
Key:  c = conifer tree          g = grass
      b = broadleaf tree        m = moss
      s = shrub                 1 = lichen
      f = forb                  o = other
```

Figure 3—Vegetation profile with both percentage of foliar cover (data from horizontal-vertical description plot) and sampled biomass for a closed paper birch community in the Bonanza Creek Experimental Forest.

```
Height                                     Foliar cover plot
(meters)

6.0   c
5.5   c
5.0   c d
4.5   c d
4.0   c d
3.5   c d
3.0   c d
2.5   c c d s s s s s s s s s s s s
2.0   c c d s s s s s s s s s s s s s s s s s s s s s g
1.5   c c d s s s s s s s s s s s s s s s s s s s s s s s s g g g g g g g f f f f f f f
1.0   c c s s s s s s s s s s s s s s s s s s s s s s s g g g g g g g g g g g g g g g f f f
0.5   c m s s s s s s s s s s s g g g g g g g g g g g g g g g f f f f f f
                        10                  20                  30                  40

                                  Percent foliar cover
```

```
Height                                     Biomass plot
(meters)

3.0
2.7
2.4
2.1
1.8   s
1.5   s s
1.2   s s s s s s s s s s s
0.9   g g s s s s s s s s s s s s s s s s s s s s s s s s
0.6   f f f f f f g g g g g g g s s s s s s s s s s s s s s s s s s s s s s s s s s s
0.3   l m m m m m g g g g g g g g f f f f f f f f f f f f f f s s s s s s s s s s s s s s s
                        10                  20                  30                  40

                            Biomass (grams per square meter)


Key:  c = conifer tree              g = grass
      b = broadleaf tree            m = moss
      s = shrub                     l = lichen
      f = forb                      o = other
```

Figure 4—Vegetation profile with both percentage of foliar cover (data from horizontal-vertical description plot) and sampled biomass for a closed spruce-birch community adjacent to Chena Hot Springs Road.

The biomass sample was conducted at an interval of 0.3 meter and showed much more detail in its profile than shown in the foliar cover profile (figs. 2 and 3) that was obtained by the forest inventory crew, although the same patterns of understory structure are present. A bulge in the amount of shrubs between 2 and 3 meters is present in both the foliar cover and the biomass profiles for the closed white spruce plot (fig. 2). In addition, both sampling methods yielded results that show a gap in shrub development between 1 and 2.5 meters in the closed paper birch stand (fig. 3). From this analysis, we were unable to determine if either sampling method confirms the other. The two methods, however, apparently result in similar estimates of vegetation structure. To accurately estimate percentage of cover in inventories, we recommend that field crews be trained to recognize detail in the understory, and not to lump layers together for simplicity and speed.

Summary

The equations presented in tables 1-7 should give reasonably accurate biomass estimates when combined with foliar cover estimates obtained by inventory crews using the vegetative profile system. Care has to be taken to ensure consistent estimates of percentage of foliar cover from one year to the next. The validity of the biomass estimates, therefore, depends on the ability of the field crew to estimate consistently the percentage of cover and to portray accurately the vertical structure of the understory vegetation.

English Conversions

1 millimeter = 0.039 inch
1 meter = 3.281 feet or 1.094 yards
1 decimeter = 3.937 inches
1 hectare = 2.471 acres
1 square meter = 10.7639 square feet
1 cubic meter = 1.308 cubic yards
1 kilogram = 2,205 pounds
1 kilogram per hectare = 0.89218 pound per acre
1.120 85 kilograms per hectare = 1 pound per acre

References

Cost, Noel D. 1979. Ecological structure of forest vegetation. In: Frayer, W.E., ed. Forest resource inventories, workshop proceedings; 1979 July 23-26; Fort Collins, CO. Fort Collins, CO: Colorado State University, Department of Forest and Wood Sciences: 29-37. Vol. 1.

Craver, Gerald C. 1982. Multiresource inventories: a technique for determining the distribution and extent of honeysuckle on commercial forest land in South Carolina. Res. Note. SE-317. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southeastern Forest Experiment Station. 11 p.

Crum, Howard. 1976. Mosses of the Great Lakes Forest. Ann Arbor, MI: University Herbarium, University of Michigan. 403 p.

Cunia, T. 1973. Dummy variables and some of their uses in regression analysis. In: Cunia, T.; Kuusela, K.; Nash, A.J., eds. Proceedings of the June 1973 meeting of International Union of Forestry Research Organizations meeting subject group S4.02, Nancy, France. Syracuse, NY: College of Environmental Sciences and Forestry, State University of New York. 146 p. Vol. 1.

Gleason, Henry A.; Cronquist, Arthur. 1963. Manual of Vascular Plants of Northeastern United States and Adjacent Canada. Princeton, NJ: D. Van Nostrand Co., Inc. 81 p.

Hale, Mason E. 1979. How to know the lichens. Dubuque, IA: Wm. C. Brown Co. 246 p.

Harcombe, P.A.; Marks, P.L. 1977. Understory structure of a mesic forest in southeast Texas. Ecology. 58: 1144-1151.

Hultén, Eric. 1974. Flora of Alaska and neighboring territories. Stanford, CA: Stanford University Press. 1008 p.

Lennartz, M.R.; McClure, Joe P. 1979. Estimating the extent of red-cockaded woodpecker habitat in the southeast. In: Frayer, W.E., ed. Forest resource inventories, workshop proceedings; 1979 July 23-26; Fort Collins, CO. Fort Collins, CO: Colorado State University, Department of Forest and Wood Sciences: 48-62. Vol. 1.

McClure, Joe P.; Cost, Noel D.; Knight, Herbert A. 1979. Multiresource inventories—a new concept for forest survey. Res. Pap. SE-191. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southeastern Forest Experiment Station. 68 p.

Phillips, Douglas R. 1981. Predicted total-tree biomass of understory hardwoods. Res. Pap. SE-223. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southeastern Forest Experiment Station. 22 p.

Setzer, Theodore S. 1987. Timber resource statistics for the Porcupine inventory unit. Resour. Bull. PNW-141. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 32 p.

Setzer, Theodore S.; Mead, Bert R.; Carroll, Gary L. 1984. Timber resource statistics for the Willow block, Susitna River basin multiresource inventory unit, Alaska, 1978. Resour. Bull. PNW-114. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. 47 p.

Sheffield, Raymond M. 1981. Multiresource inventories: techniques for evaluating nongame bird habitat. Res. Pap. SE-218. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southeastern Forest Experiment Station. 28 p.

Smith, W. Brad; Brand, Gary J. 1983. Allometric biomass equations for 98 species of herbs, shrubs, and small trees. Res. Note NC-299. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station. 8 p.

Stanek, W.; State, D. 1978. Equations predicting primary productivity (biomass) of trees, shrubs and lesser vegetation based on current literature. Rep. BC-X-183. Victoria, BC: Canadian Forestry Service, Pacific Forest Research Centre. 58 p.

U.S. Department of Agriculture, Forest Service. 1981. Tree biomass: a-state-of-the-art compilation. Gen. Tech. Rep. WO-33. Washington, DC. 34 p.

U.S. Department of Agriculture, Soil Conservation Service. 1986. Susitna River basin study—timber and vegetation resources of the Susitna River basin—Alaska report. Anchorage, AK. 49 p. and apps.

Viereck, Leslie A.; Dyrness, C.T. 1980. A preliminary classification system for vegetation of Alaska. Gen. Tech. Rep. PNW-106. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. 38 p.

Viereck, Leslie A.; Little, Elbert L., Jr. 1972. Alaska trees and shrubs. Agric. Handb. 410. Washington, DC: U.S. Department of Agriculture. 265 p.

Welsh, Stanley L. 1974. Anderson's flora of Alaska and adjacent parts of Canada. Provo, UT: Brigham Young University Press. 724 p.

Yarie, John; Mead, Delbert R. 1982. Aboveground tree biomass on productive forest land in Alaska. Res. Pap. PNW-298. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. 16 p.

Appendix

Scientific name	Common name	Source of scientific name
Alnus crispa (Ait.) Pursh	American green alder	Viereck and Little 1972
Alnus tenuifolia Nutt.	thinleaf alder	Viereck and Little 1972
Aulacomnium Schwaegr.	bog moss	Crum 1976
Betula glandulosa Michx.	resin birch	Viereck and Little 1972
Betula nana L.	dwarf arctic birch	Viereck and Little 1972
Betula occidentalis Hook.	water birch	Welsh 1974
Brachythecium B.S.G.	small capsule moss	Crum 1976
Calamagrostis canadensis (Michx.) Beauv.	bluejoint grass	Welsh l974
Carex aquatilis Wahl.	water sedge	Welsh 1974
Carex bigelowii Torr.	bigelow sedge	Welsh 1974
Carex L.	sedge	Welsh 1974
Cetraria cucullata (Bell.) Ach.	fruticose lichen	Hale 1979
Cetraria islandica (L.) Ach.	Iceland "moss"	Hale 1979
Cladina	reindeer lichen	Hale 1979
Cladonia	cup-stalk lichen	Hale 1979
Cornus canadensis L.	bunchberry	Welsh 1974
Dicranum Hedw.	broom moss	Crum 1976
Dryas drummondii Richards.	drummond mountain-avens	Viereck and Little 1972
Empetrum nigrum L.	crowberry	Viereck and Little 1972
Epilobium angustifolium L.	common fireweed	Welsh 1974
Equisetum arvense L.	field horsetail	Welsh 1974
Equisetum variegatum Schleich.	variegated scouring rush	Welsh 1974
Eriophorum vaginatum L.	tussock cottongrass	Welsh 1974
Geocaulon lividum (Richards.) Fern..	northern commandra	Welsh 1974
Hepatica Hill.	liverworts	Gleason and Cronquist 1963
Hylocomium splendens (Hedw.) B.S.G.	stair-step moss	Crum 1976
Hypnum Hedw.	moss	Crum 1976
Ledum groenlandicum (Oeder)	Labrador tea	Viereck and Little 1972
Ledum palustre ssp. *decumbens* (Ait.) Hult.	northern Labrador tea	Hultén 1974
Linnaea borealis L.	twin-flower	Viereck and Little 1972
Louiseleuria procumbens (L.) Desv.	alpine azalea	Viereck and Little 1972
Mertensia paniculata (Ait.) G. Don	tall bluebell	Welsh 1974
Peltigera spp.	lichen	Hale 1979
Peltigera apthosa (L.) Willd	veined lichen	Hale 1979
Picea glauca (Moench) Voss	white spruce	Viereck and Little 1972
Picea mariana (Mill.) B.S.P.	black spruce	Viereck and Little 1972
Pleurozium schreberi (Brid.) Mitt.	Schreber's moss	Crum 1976
Polytrichum juniperinum Hedw.	juniper moss	Crum 1976
Populus balsamifera L.	balsam poplar	Viereck and Little 1972
Potentilla fruticosa L.	bush cinquefoil	Viereck and Little 1972
Pyrola grandiflora Radius	one-sided wintergreen	Welsh 1974
Pyrola L.	wintergreen	Welsh 1974
Pyrola secunda L.	large-flowered wintergreen	Welsh 1974
Rhytidiadelphus triquetrus (Hedw.) Warnst.	shaggy moss	Crum 1976
Ribes triste Pall.	American red currant	Viereck and Little 1972
Rosa acicularis Lindl.	prickly rose	Viereck and Little 1972
Rubus chamaemorus L.	cloudberry	Welsh 1974
Salix alaxensis (Anderss.) Cov.	feltleaf willow	Viereck and Little 1972
Salix bebbiana Sarg.	bebb willow	Viereck and Little 1972
Salix glauca L.	grayleaf willow	Viereck and Little 1972
Salix novae-angliae Anderss.	tall blueberry willow	Viereck and Little 1972
Salix planifolia Pursh spp. *pulchra* (Cham.) Argus	diamondleaf willow	Viereck and Little 1972
Shepherdia canadensis (L.) Nutt.	russet buffaloberry	Viereck and Little 1972
Sphagnum L.	spagnum moss	Crum 1976
Stereocaulon	rock lichen	Hale 1979
Vaccinium uliginosum L.	bog blueberry	Viereck and Little 1972
Vaccinium vitis-idaea L.	mountain cranberry	Viereck and Little 1972
Viburnum edule (Michx.) Raf.	highbush cranberry	Viereck and Little 1972

Yarie, John; Mead, Bert R. 1988. Twig and foliar biomass estimation equations for major plant species in the Tanana River Basin of interior Alaska. Res. Pap. PNW-RP-401. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 20 p.

Equations are presented for estimating the twig, foliage, and combined biomass for 58 plant species in interior Alaska. The equations can be used for estimating biomass from percentage of foliar cover of 10-centimeter layers in a vertical profile from 0 to 6 meters. Few differences were found in regressions of the same species between layers except when the ratio of foliar-to-twig biomass changed drastically between layers; for example, *Rosa acicularis* Lindl. Eighteen species were tested for regression differences between years. Thirteen showed no significant differences; five were different. Of these five, three were feather mosses for which live and dead biomass are easily confused when measured.

Keywords: Biomass equations, Alaska (interior), Alaska (Tanana Valley), inventory (wildlife habitat).

U.S. Department of Agriculture
Pacific Northwest Research Station
319 S.W. Pine Street
P.O. Box 3890
Portland, Oregon 97208

Official Business
Penalty for Private Use, $300

BULK RATE
POSTAGE +
FEES PAID
USDA-FS
PERMIT No. G-40

do NOT detach label